

Atmos. Chem. Phys. Discuss., referee comment RC1
<https://doi.org/10.5194/acp-2021-738-RC1>, 2021
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Comment on acp-2021-738

Anonymous Referee #2

Referee comment on "Aerodynamic size-resolved composition and cloud condensation nuclei properties of aerosols in a Beijing suburban region" by Chenjie Yu et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-738-RC1>, 2021

This manuscript by Yu et al. introduced the aerodynamic size-resolved chemical composition and CCN activity of aerosols in the Beijing suburban region. The study combined an aerosol aerodynamic classifier (AAC) with a set of aerosol physical and chemical measurements and focused on the properties of refractory black carbon-containing particles (rBCc). The study found that rBCc are relatively spherical at sizes above 300 nm, and the number fraction of rBC increases as a function of particle size. Due to the coating properties and their larger sizes, a relatively large fraction of the rBCc could also be activated to contribute to cloud formation. The manuscript is well organized. I recommend the publication of the manuscript after the following minor revisions.

General comments:

- I found the higher number fraction and larger MMD of rBC at larger sizes very interesting. The authors attributed this phenomenon to particle coagulation. Is this coagulation happening among the rBC particles or between rBC and other larger particles? Considering that fresh soot particles directly generated from engines are relatively small (~ 100 nm), how fast is this coagulation process and how does the involvement of other chemical species affect the evolution of rBC?
- The coating thickness D_p/D_c showed a minimum value at the size of around 300 nm. The authors imply that traffic emissions may play a role in this change of coating properties. Could the authors elaborate more on the detailed mechanisms?

Detailed comments:

- Page 4 Line 103: There are a few more studies on size-resolved CCN activity and aerosol physiochemical properties in Beijing, such as the following ones. Probably the authors want to stress that this study focused on rBC and used an AAC to size-classify the aerosols.

Gunthe, S.S., Rose, D., Su, H., Garland, R.M., Achtert, P., Nowak, A., Wiedensohler, A., Kuwata, M., Takegawa, N., Kondo, Y. and Hu, M., 2011. Cloud condensation nuclei (CCN) from fresh and aged air pollution in the megacity region of Beijing. *Atmospheric Chemistry and Physics*, 11(21), pp.11023-11039.

Fan, X., Liu, J., Zhang, F., Chen, L., Collins, D., Xu, W., Jin, X., Ren, J., Wang, Y., Wu, H. and Li, S., 2020. Contrasting size-resolved hygroscopicity of fine particles derived by HTDMA and HR-ToF-AMS measurements between summer and winter in Beijing: the impacts of aerosol aging and local emissions. *Atmospheric Chemistry and Physics*, 20(2), pp.915-929.

Wu, Z., Zheng, J., Wang, Y., Shang, D., Du, Z., Zhang, Y. and Hu, M., 2017. Chemical and physical properties of biomass burning aerosols and their CCN activity: A case study in Beijing, China. *Science of the Total Environment*, 579, pp.1260-1268.

- Page 4 Line 113: One of the disadvantages for the AMS measuring the size-resolved composition is that the AMS cannot measure CCN related sizes (50 to 100 nm). But it appears that the AAC was used in size range of 90 to 1100 nm, which is not significantly better than the AMS measurement range.
- Page 7 Eq. (2): How was rou_{NR} calculated? It may be better to include a table of nomenclature to introduce each of the parameters and how they are measured (by which instrument) or calculated.
- Page 7 Eq. (5): How was $\text{epsilon}_{\text{coating},i}$ measured or calculated? Also, in Fig. 5h, the kappa values for rBCc are sometimes higher than those of all particles. Is this reasonable?
- Page 9 Line 252: "idea" change to "ideal"
- Page 9 Line 254: Was the scanning of the SS done in this work? In the methods section, the SS was fixed at 0.2%.
- Page 10 Line 296: "... non-refractory aerosol mass concentrations during light pollution periods show limited size-dependent variation." There are indeed significant variations as a function of particle size, although the absolute concentrations are relatively low.
- Page 10 Line 306: Why was the Org highly oxidized in Beijing suburban? It may be better to elaborate this observation in more details.
- Page 13 Line 400: "Fine rBC condensed ..." Since rBC are in the particle phase, not in the vapor phase, they cannot "condense" onto pre-existing particles.
- Page 15 Line 456: remove "and".
- Fig. 5b, 5c, 5d, 5e and 7a, 7b: Should the labels on the y-axes "dM" and "dN" be "dM/dlogDp" and "dN/dlogDp"? Also, why are the error bars shown in the positive direction only?
- Fig. 8: Please show the legends in panels b and c (black curve is not introduced).